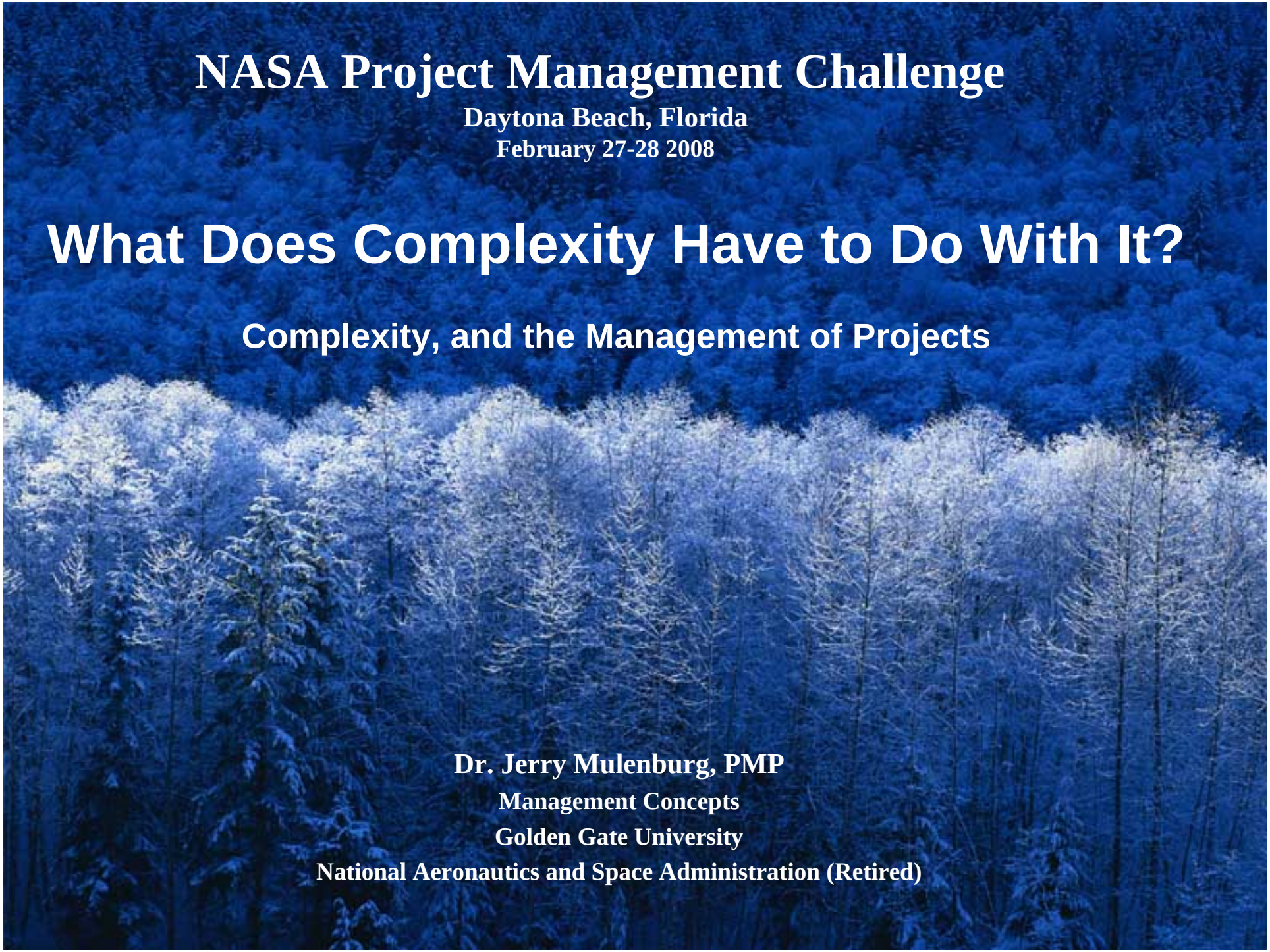


NASA Project Management Challenge

Daytona Beach, Florida
February 27-28 2008

What Does Complexity Have to Do With It?

Complexity, and the Management of Projects

Dr. Jerry Mulenburg, PMP
Management Concepts
Golden Gate University
National Aeronautics and Space Administration (Retired)

What is complexity anyway?

Complexity, the poetry of what we know and what we don't.

As we know,
There are knowns and unknowns.

There are known - knowns.
These are the things we know we know.

We also know there are known - unknowns.
That is to say, there are some things we know we do not know.

But there are also unknown - unknowns.
These are things that we don't know we don't know.

Donald Rumsfeld, Secretary of Defense

Complex:

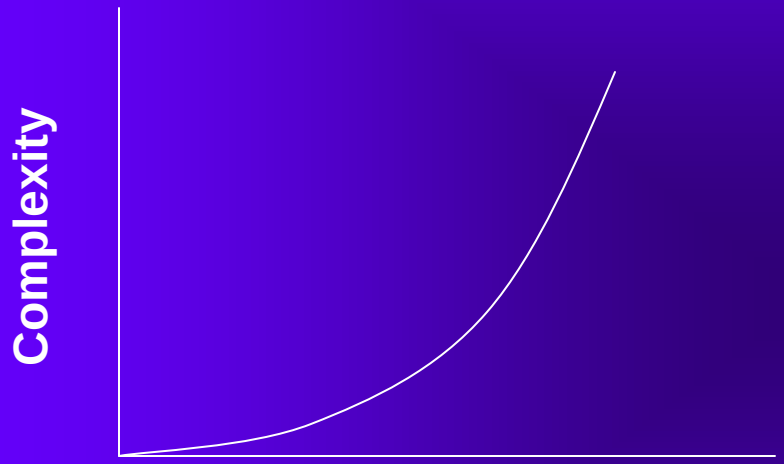
1. **Composed of many interconnected parts**
2. **Characterized by a complicated or involved arrangement of parts, units, etc.**
3. **So complicated or intricate as to be hard to understand or deal with**

Webster's Encyclopedic Unabridged Dictionary, 2001

CAUSES OF COMPLEXITY

- The state of the environment

Details – number of variables and interfaces
Ambiguity – lack of awareness of events and causality
Uncertainty – inability to pre-evaluate actions
Dynamics – rapid rate of change
Social structure – numbers and types of interactions



- System of systems
- Systems
- Sub-systems
- Functions
- Sets of elements
- Elements

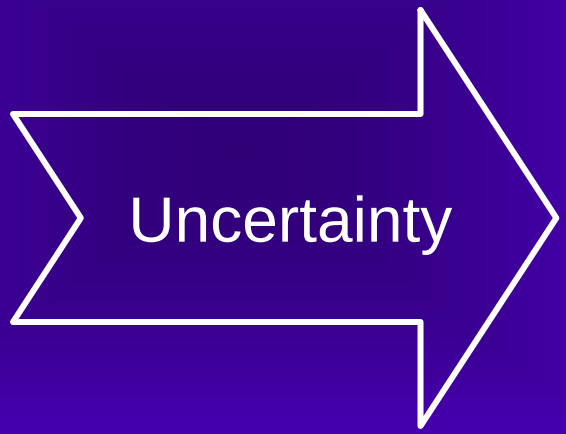
- Intelligence
- Innovation
- Energy
- Attention
- Time

Additional Needs

What is a complex project?

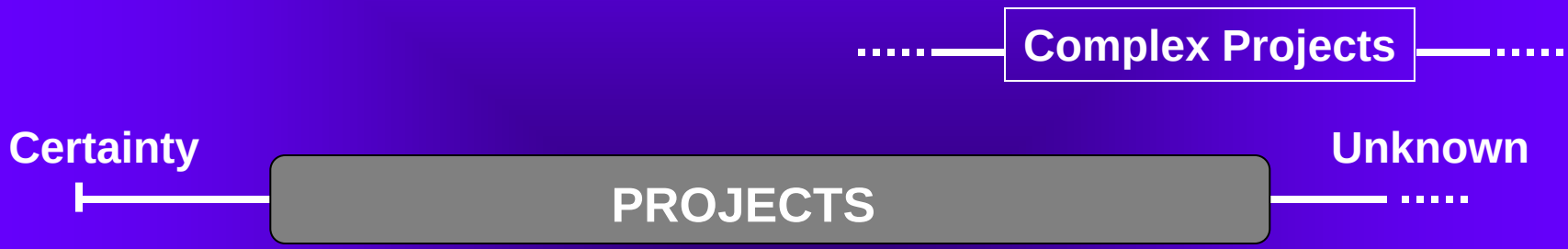
The Critical Role of the NASA Project Manager

Intangible
Understanding the Features & Functionality Required/Desired



Tangible
Creating a Product to Provide the Features & Functionality

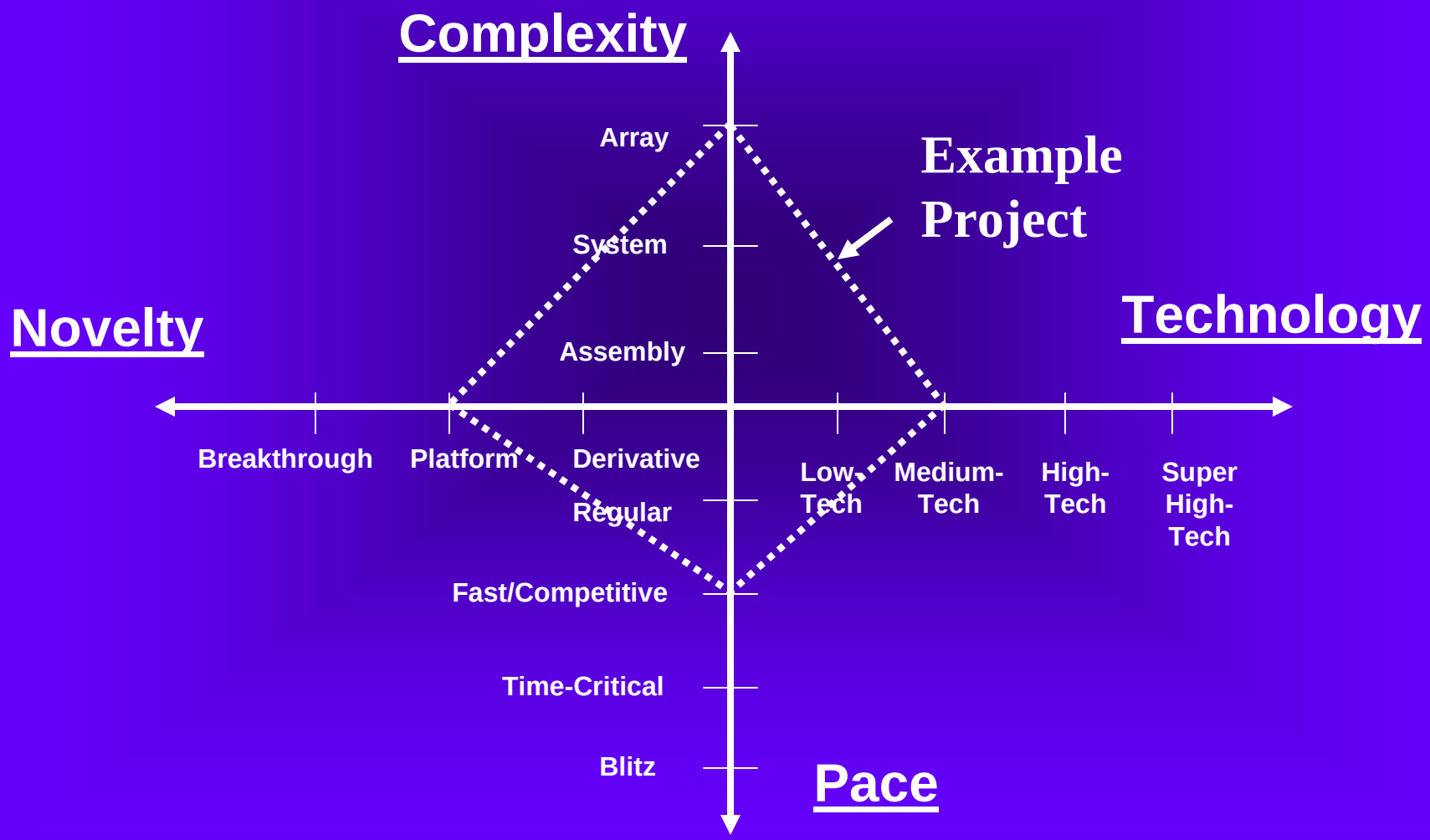
COMPLEXITY SPECTRUM



Conceptual Models Exist	Modified Models Exist	Few or No Existing Models
Critical Path	Agile	Late Design Freeze
PERT	Extreme	Redundancy
Critical Chain	Skunk Works	Experiment
Waterfall	Lean	Multiple Parallel Solutions
Spiral	...	...
...		

NCTP Model

(Aaron Shenhar, Stevens Institute of Technology)



What is needed to manage a complex project?

What is needed to manage a complex project?

A Complex-Project Manager!

What makes a complex project manager?
(or anyone who can do something well)

Ability: (being good at something)

Knowledge	**- books, study**
Skill	**- practice**
Experience	**- performance**
Intelligence	**- genes +**

What is intelligence?

What is “Intelligence”?

Piaget:

- Sensorimotor & assimilation cognitive development

Goddard, Yerkes, Burt, Thurstone, Terman, et al.:

Linguistic-mathematical (g and IQ)

Gardner:

7 + 1 – Linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, + naturalistic

Salovey:

Emotional – Ability to monitor one’s own and other’s feelings and emotions, to discriminate

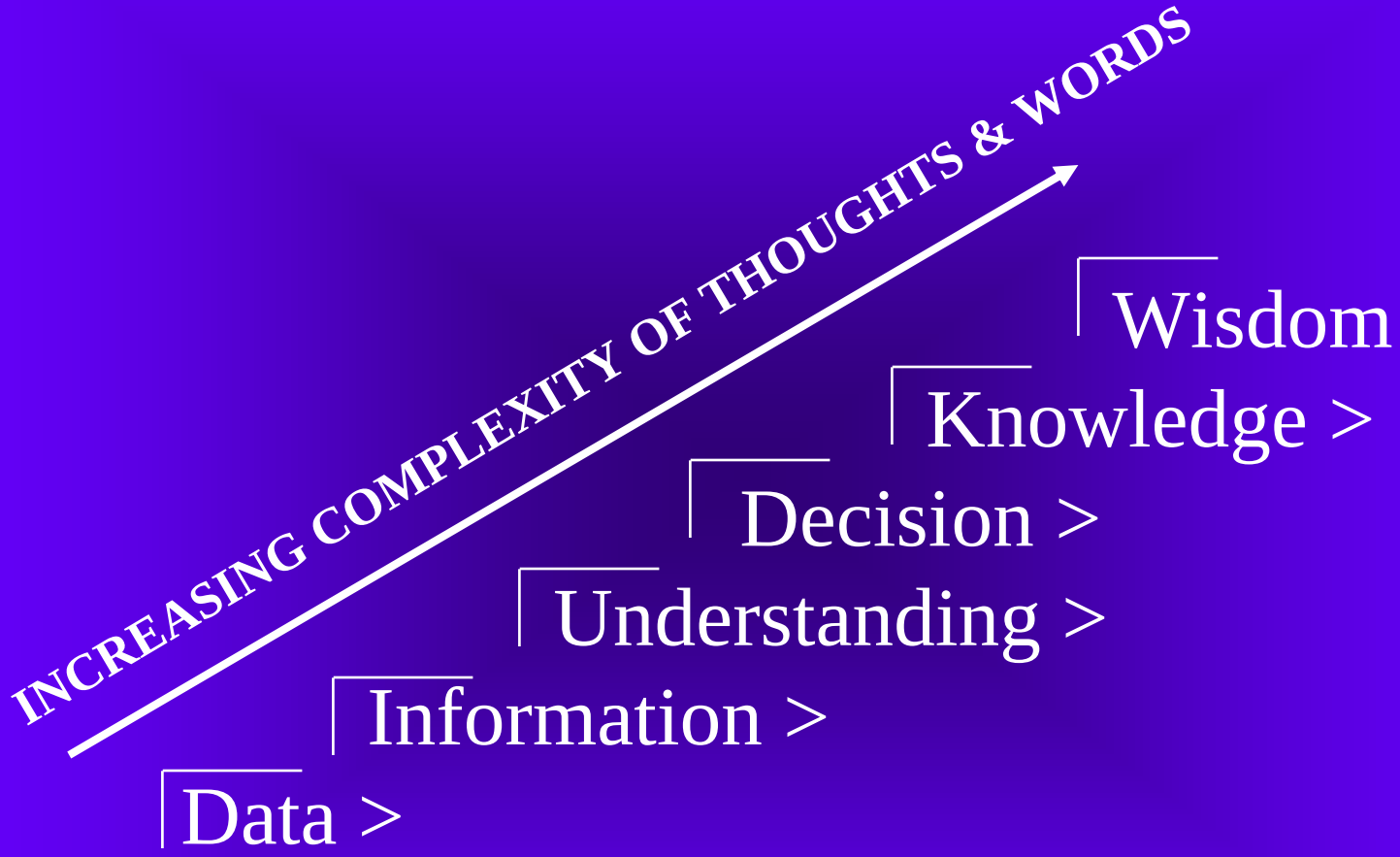
•Albrecht:

Social - Ability to get along with other & get their cooperation

Goleman:

Emotional – Self-awareness, self-regulation, motivation, empathy, social skills

Social - Awareness and facility in dealing with selves and others


INCREASING COMPLEXITY OF THOUGHTS & WORDS
Wisdom
Knowledge >
Decision >
Understanding >
Information >
Data >

JAQUES' STRATIFIED SYSTEMS THEORY

CAPACITY FOR WORK – HUMAN DISCRETION & JUDGEMENT

WORK: THE EXERCISE OF DISCRETION, JUDGMENT & DECISION-MAKING IN CARRYING OUT TASKS (THINGS YOU HAVE TO THINK AND MAKE DECISIONS ABOUT)

WORK CAPACITY: THE LEVEL OF KNOWLEDGE, SKILL, WISDOM, & TEMPERAMENT AVAILABLE TO DO WORK

WORK, & PROJECT MANAGEMENT, HAVE TO DO WITH PROBLEM SOLVING

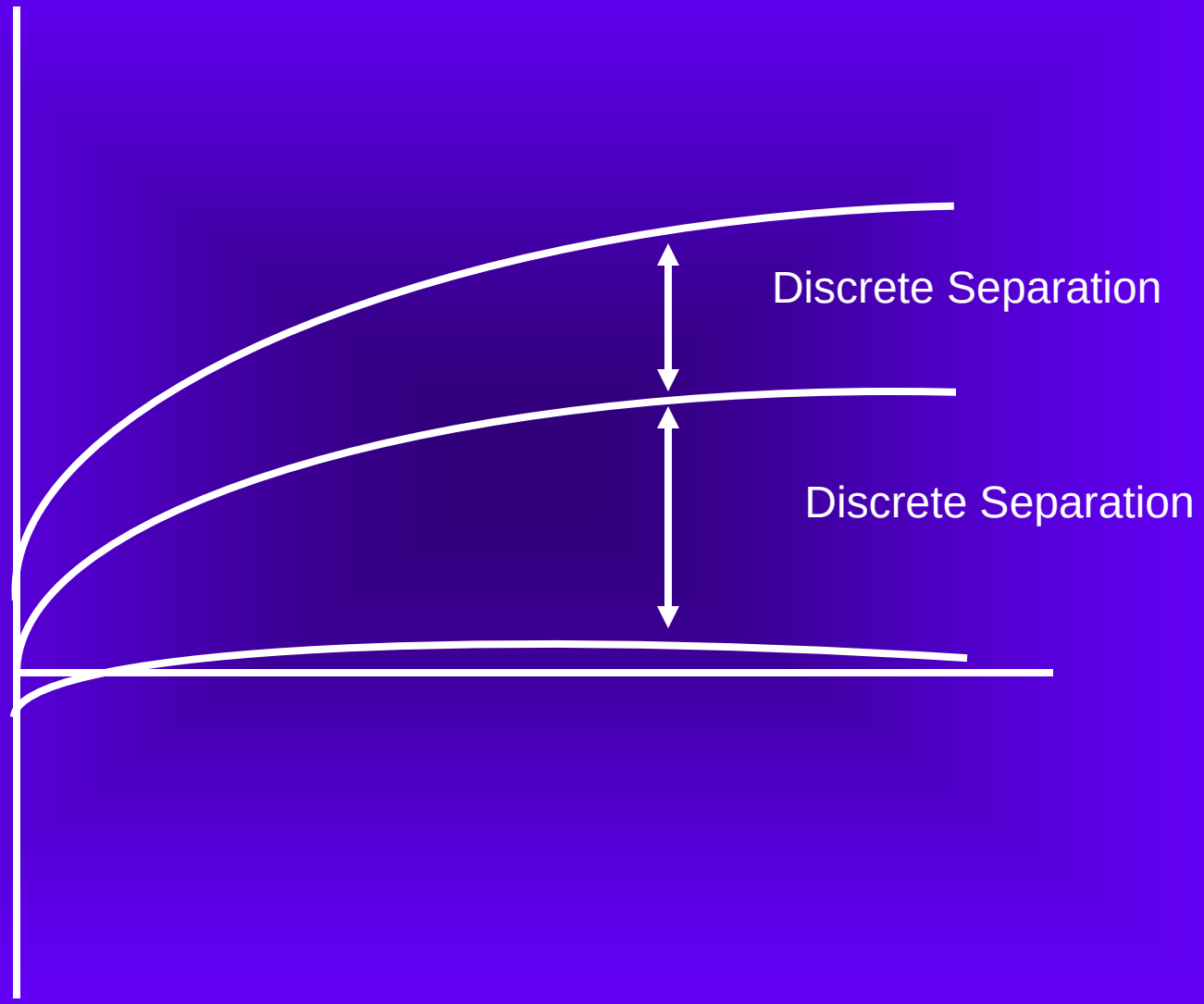
- **IDENTIFYING & SETTING A GOAL (PROJECT PURPOSE)**
- **FINDING A WAY TO ACHIEVE THE GOAL (SOLUTION FINDING)**
- **DETERMINING RESOURCE REQUIREMENTS**
- **RECOGNIZING LIMITS (CONSTRAINTS)**
- **SELECTING A PATH TO THE GOAL (EQUIFINALITY)**
  - **KNOWN: SIMPLE**
- **UNCERTAIN: COMPLEX, MULTIPLE VARIABLES**
  - **VERBAL & NON-VERBAL**

THE *TIME-SPAN* OF WORK IS THE LEVEL OF COMPLEXITY OF A ROLE

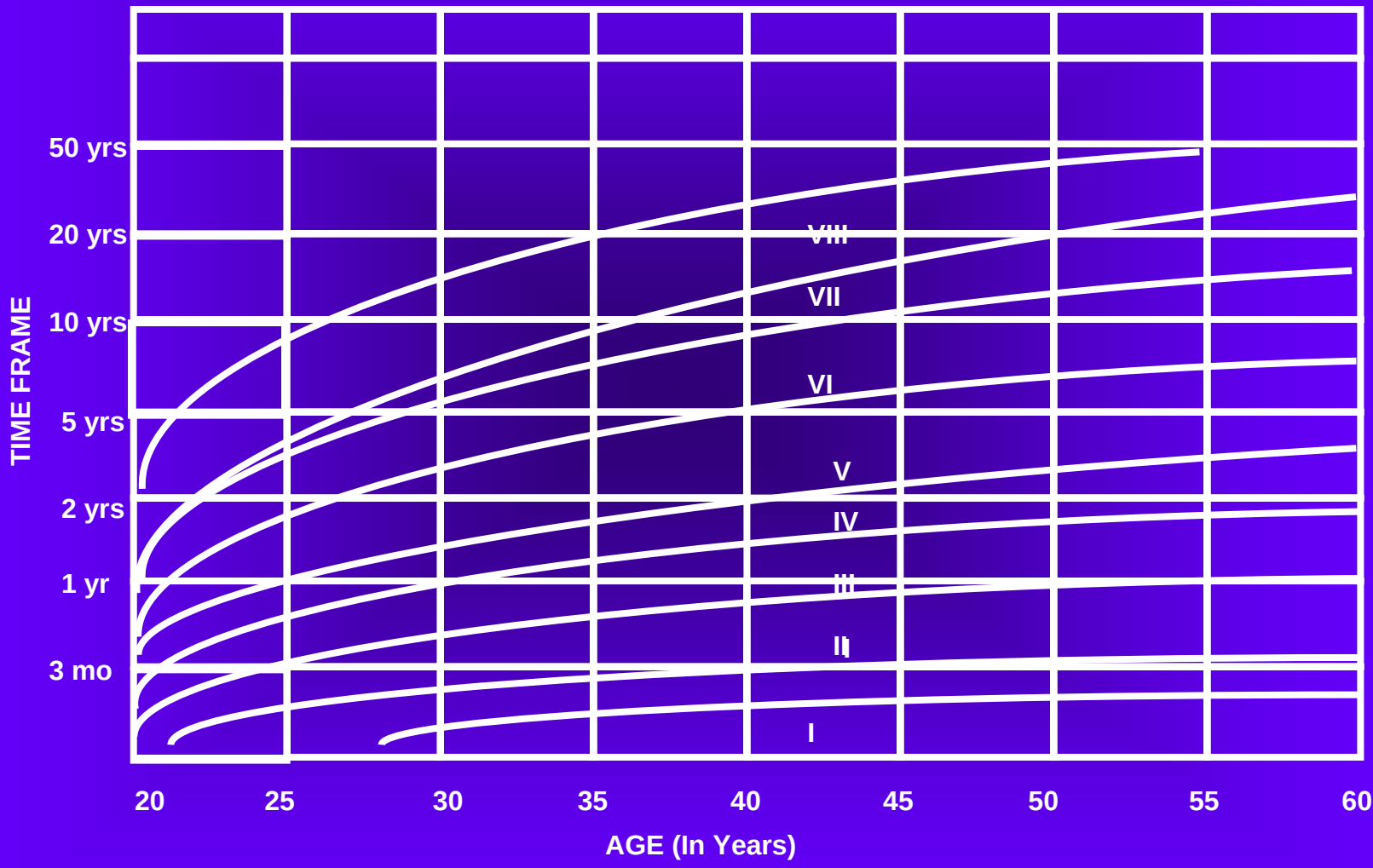
- **THE MAXIMUM TARGET TIME IS FOR THE LONGEST TASKS**
- **THE LONGER TIME SPAN = GREATER WORK CAPACITY REQUIRED**

TIME SPAN OF WORK ⇨ **COMPLEXITY** ⇨ **UNCERTAINTY** ⇨ **DISCRETION**

Jaques' Stratified Systems Theory

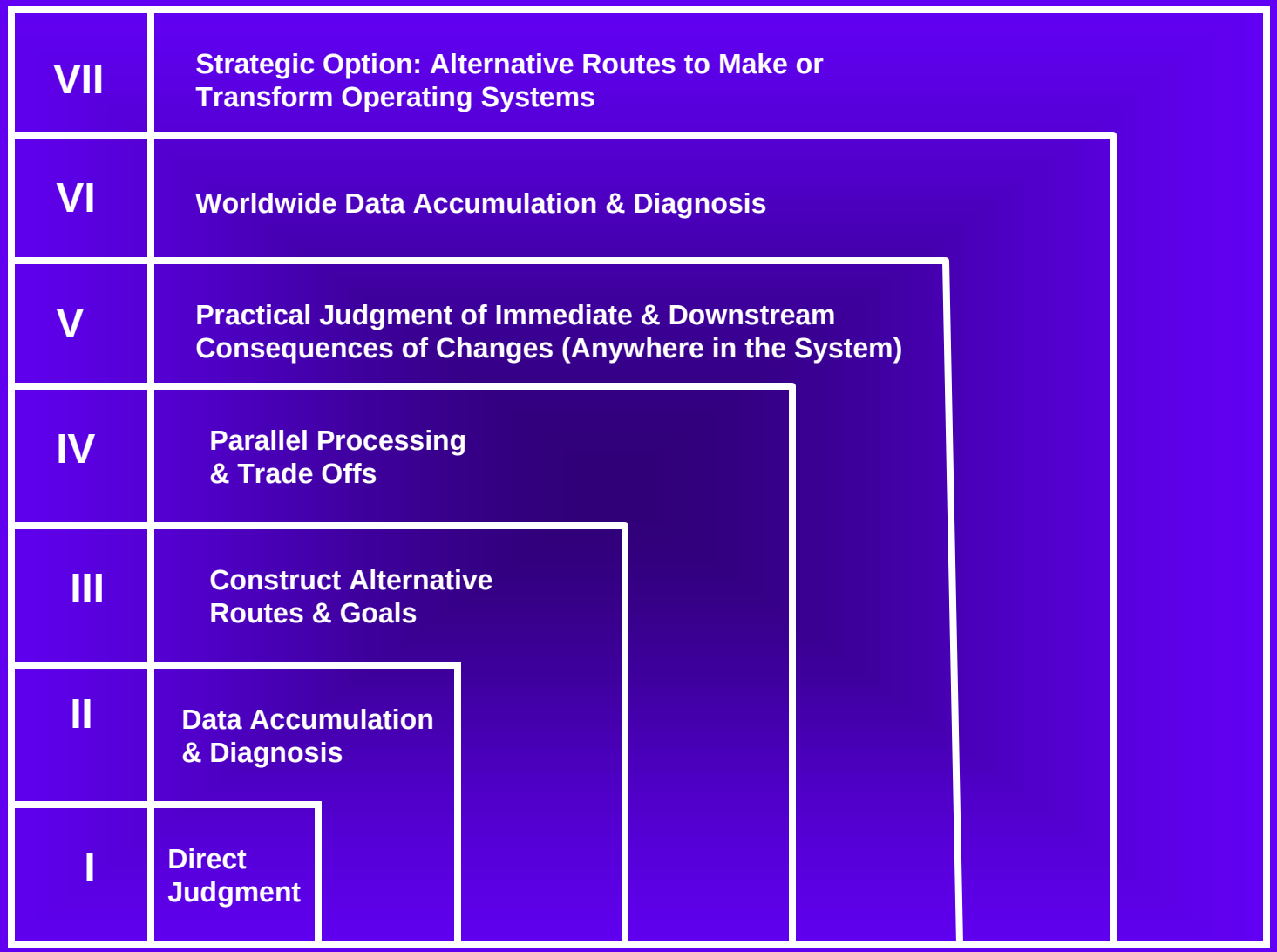


Jaques' Stratified Systems Theory



RELATING STRATIFIED SYSTEMS THEORY TO PROJECT MANAGEMENT

Jaques' Stratified Systems Theory



Can the Level of Verbal Processing of Information by a Project Manager be Used To Determine their Current Level of Project Management Capability?

Bucy: A Typology of Reasoning Based on Elliott Jaques' Quintave Model

Stamp: Longitudinal Research Methods of Assessing Managerial Potential

Jaques' Stratified Systems Theory

COGNITIVE PROCESSES (ARTICULATED THOUGHT)

- THE MENTAL PROCESSES BY WHICH YOU TAKE INFORMATION, ANALYZE IT, MAKE CONCLUSIONS, PLANS, & DECISIONS (ANALYSIS, ORGANIZATION, JUDGMENT, REASONING, REACHING CONCLUSIONS, PLANNING, MAKING DECISIONS FOR ACTION)

COGNITIVE POWER (WORK CAPACITY)

– A MEASURE OF THE MAXIMUM SCALE & COMPLEXITY YOU ARE ABLE TO APPLY AT A GIVEN TIME

(ABILITY TO HANDLE COMPLEXITY – WORDS, IDEAS, FORMULAS, MODELS, DESIGNS. MATHEMATICS & OTHER SYMBOLS)

SKILL (LEARNED PSYCHOMOTOR PATTERNS & CALCULATING ROUTINES)

- THE ABILITY TO ORGANIZE AND SIMPLIFY WORK & PROBLEM SOLVING

Jaques' Stratified Systems Theory

IV PARALLEL PROCESSING IF-AND-ONLY-IF (UNIVERSAL-BI-CONDITIONAL)
Considering a number of linked serial results in parallel. "If this, which leads to A then B but is unsupportable, but considering C leading to D also unsupportable, E leading to F is workable but only if B is included between E and F."

III CUMLATIVE PROCESSING AND-AND (SYMBOLIC-CONJUNCTIVE)
Bringing together a number of different ideas, each insufficient alone, but as a group make a case. "Taking this, and putting it with this and that, it's clear."

II SERIAL PROCESSING IF THEN-THEN (CONCEPTUAL-CONDITIONAL)
Constructing a sequence of reasons, each leading to the next creating a chain. "Do A which will lead to B then to C, and then to what is needed.)

I DECLARATIVE PROCESSING OR-OR (CONCRETE-DISJUNCTIVE)
Bringing together a number of separate reasons without connecting the reasons." Here's a reason. Here's another, and I have others also."

COMPLEXITY RELATIONSHIPS

Theory, Philosophy	Complex Processing	Theory of Relativity Quantum Physics
Systems of Systems	Parallel Processing	Return to the Moon, Mars Apollo Manhattan Project
Conceptual Systems	Serial Processing	Pyramids Great Wall of China ISS
Symbolic Logical arrangements	Cumulative Processing	New Buildings Computer Systems
Concrete Things	Declarative Processing	Tasks Assemblies

INFORMATION PROCESSING WITHIN STRATA

Time Span	Mental Complexity	Mental Process	Application to Project Complexity
IV	Universal	Parallel	Systems of systems to accomplish mission objectives
III	Conceptual	Serial	Combining subassemblies & subsystems into complex assemblies & systems
II	Symbolic	Cumulative	Combining tasks needed to develop subassemblies or subsystems
I	Declarative	Concrete	Activities needed to accomplish tasks

COMPLEXITY RELATIONSHIPS

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INFORMATION PROCESSING WITHIN STRATA

IV

2 YR – 5 YR

Parallel
Cumulative
Serial
Declarative

III

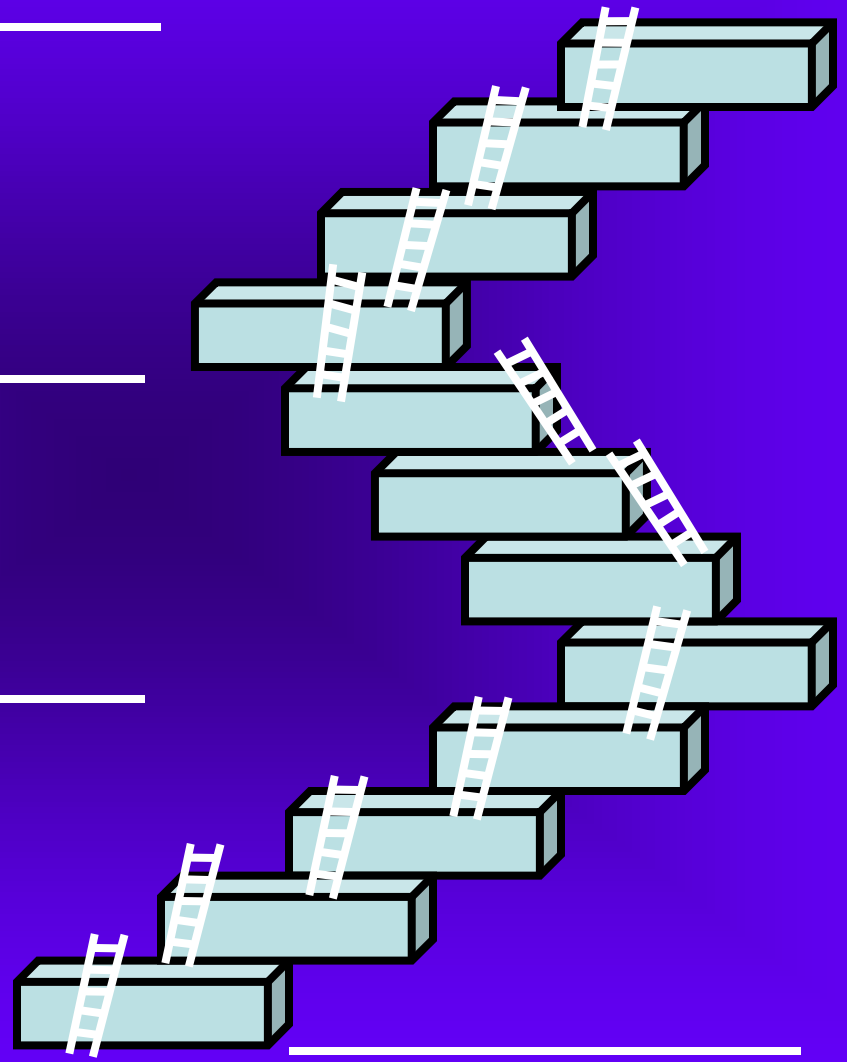
1 YR – 2 YR

Parallel
Cumulative
Serial
Declarative

II

3 MO – 1 YR

Parallel
Cumulative
Serial
Declarative



Mental Processes	Description of Language Used
Parallel **IF-AND-ONLY-IF**	Examining a number of other possible positions held in parallel and linked together, each arrived at by means of serial processing. EXAMPLE: Beginning with a position that leads to A and B and ends in outcome 1, which I do not support, or starting with another position that leads to C and then to D to get to outcome 2, which I also do not support. A third position could lead to E and then to F, ending in outcome 3 that I do favor, but only if you took B and put it between E and F on the way to outcome 3.
Serial **IF-THEN-THEN**	Constructing a line of thought made up of a sequence of reasons, each one leading to the next, creating a chain of linked reasons to make the conclusion. EXAMPLE: I would do A, and because it would lead to B, and B will lead to C, and C will lead me to where I want to get. (Each reason leads to the next reason, and so on.
Cumulative **AND-AND**	Bringing together a number of different ideas, none of which is sufficient to make a case, but taken together they do make the case. EXAMPLE: If you take this idea and put it together with these other three items it becomes clear that such-and-such has occurred.
Declarative **OR-OR**	Bringing together a number of separate reasons for taking a particular position on an issue. EXAMPLE: Here's one reason for my idea, and here's another, and I could also give you others.

Conclusions